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## CONTENTS

Functional Mathematics in the Second Grade ..... 217
EDNA SALT, *University School, Ohio State University*

Arithmetic with Understanding ..... 228
JOSEPHINE H. MACLATCHY, *Bureau of Educational Research, and* EUGENIE HUMMEL, *Bexley Public Schools*

Editorial Comment ..... 239

Readings ..... 241

BOOKS TO READ—*The Reading of Verbal Material in Ninth Grade Algebra, Units of Work and Centers of Interest in the Organization of the Elementary School Curriculum, Science Education in Consumer Buying, Using Dollars and Sense, Wise Spending, Predicting the Child's Development, Writing and Laterality Characteristics of Stuttering Children, Mathematics Instruction in the University High School.*

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# Functional Mathematics in the Second Grade

*By* EDNA SALT

THE children of the second primary group in the Ohio State University School were concerned with a unit of work on the sources and transportation of the foods they ate. As a part of this study they visited a large retail grocery where they saw the equipment used and the work done behind the scenes in such a market. This trip inspired many questions about where this grocery obtained its supplies. In order to build a more complete understanding of the people and procedures involved in supplying a grocery with its produce, arrangements were made for these seven-year-olds to visit wholesale fruit and vegetable markets, a railroad terminal where refrigerator cars were being unloaded, and a large wholesale grocery.

Of course, the children were interested in the terms *wholesale* and *retail*. They began to realize that they and their parents always bought from a retail market, and that the retail grocers bought from the wholesalers. Many group discussions were held to clarify these two terms. The children also talked with their parents at home and gathered much helpful information.

As a result of these discussions and trip experiences, there was much dramatic play in which these boys and girls pretended that they were grocers. One day one boy mentioned during a discussion that he thought it would be good for the group to have a store. This suggestion received the approval of the others, and the teacher was asked whether this was possible. The question was raised about the kind of store they wanted. Some suggested a "play" store with empty cartons and cans being used for merchandise. Others felt that this was silly and said that they wanted real things to sell. The entire group felt

that it would be more interesting to have a genuine store if possible. One of the first things these children realized was that they would have to find out whether or not a wholesale dealer would sell to them since they were not bona fide grocers. Letters were written to one of the firms that they had visited, and the father of one of the children who was a retail grocer was asked to help in obtaining the consent of the wholesale grocer. When it was determined that it was possible for the class to obtain the goods at wholesale prices, the boys and girls began to discuss where they could have their store and what was to go in it. They decided that there was space in their own room to build a small store; then the weighty problem of choosing the goods was discussed.

When they were asked how they were going to pay for their groceries, they very glibly replied that they would just write a check. One child said he didn't think it was possible for the class to do this inasmuch as it had no money in the bank. This was startling news to many of the children. "Do you mean we have to have money in the bank before we can write a check?" they asked. This child thought he was right about it, so the boys and girls all decided that they would ask their parents. The next day there was considerable consternation in the group when the children reported back that the parents who wrote checks all had money in the bank. For a time it looked to them like the end of their splendid idea. The facts were clearly brought out that people deposit money in the bank, then write checks, and for a small charge the bank pays the money to the person receiving the check. These boys and girls thus began to appreciate some of the elementary principles of banking.

Out of this dilemma came the suggestion that, since the group could not write a check for groceries, it might be possible to "charge" them. This seemed to them to be an easy way out of their difficulties, but they were helped to understand that credit was given by business firms only to "grown-ups" and then only to those who had shown that they were capable of paying. Again it seemed that they were in difficulty. Finally, they decided that they might borrow the money they needed, but there was still the problem of finding someone to lend them the necessary amount.

The teacher suggested that perhaps the Student Council might lend them what they needed, for the Council made a practice of lending money to older groups of boys and girls for worth-while projects. Several members of the Council were asked to come in and talk over the problem with the group. The president assured the children that there was a possibility of the Council's lending them the money if it were not too large a sum. Since, of course, the boys and girls had no idea at this time what amount they would need, their next step was quite apparent.

AFTER much discussion the children agreed that first of all they would like to sell canned goods in their store, and then if this were successful they might like to try fresh vegetables or baked goods. They readily recognized that with their limited space and money they could not hope to stock everything in their store which the grocer ordinarily has. Therefore they decided on canned peaches, pears, apricots, cherries, orange juice, grapefruit juice, pineapple juice, peas, corn, spinach, green beans, lima beans, and tomatoes. They requested the wholesale grocer to send them the prices on these items. When the price list arrived, some of the children could not read the amounts of money that were listed, so they were given help in understanding about the dollar sign, the decimal point, and the place for dollars and for cents. By the time the complete price list, which had been mimeographed so that each child might have one, had been checked, these children were able to read the amount of money with little or no difficulty.

They were surprised to find that most of the items on the price sheet were listed at so much a case. "What is a case?" was the general question. The little girl whose father was the grocer said she thought it was 24 cans, and that she would find out for the group. The children were also puzzled by some of the prices being so much a dozen. A few of the boys and girls knew how many things were in a dozen, and they helped the others to learn about this by showing them a dozen people, books, chairs, and the like. They also talked about things that were usually bought by the dozen such as eggs, oranges, and ears of corn. Everyone in the group was soon able to understand the difference between a dozen and a case, and very soon discovered that 2 dozens made a case or that

half a case was a dozen. A case of any one vegetable or fruit seemed like a large number of cans to these children, and they saw another reason why the ordinary person could not or did not wish to buy from a wholesale dealer even if he could.

Another thing on this price list which puzzled the children was the reference to the various sizes of the cans. They had no idea to what No. 2½ referred. When they were told that it referred to size they began reporting back to the group that their mothers usually bought such-and-such a size can of tomatoes, corn, and the like. The teacher obtained a complete set of empty cans of all sizes and brought these into the classroom. The children handled them, judged or described what would be packed in each size, and then used these cans in their dramatic play. All these experiences and the constant reference to the various sizes soon enabled each child to be aware of and able to talk about the desirable size for the store.

THE question of how much a single can would cost was raised quickly. A few of the cases cost $2.40, and some of the children were able to figure out that a single can thus cost 10 cents. This figuring was usually done by the child's adding 10 cents 24 times and discovering that it made $2.40. Since these children were too young and their mathematical understandings too limited to do the difficult division work necessary to figure the cost per can, this was done for them.

Soon after the boys and girls were given the wholesale cost per can of the various items, they began to notice that this price did not tally with the cost of the same item when they or their parents bought it at their retail store. As one child stated it: "That No. 2 size can of tomatoes cost my mother 13 cents at the grocery last night. How can we buy it for 9 cents here at school from K———'s( the wholesale dealer) and my mother has to pay 13 cents for the same thing?" The children were asked to check at their grocers' the items which the group was considering buying to see if this fact were generally true, or if this one boy's experience was merely an unusual instance. Naturally, all the children found that they paid more at their retail grocers', and they were much perturbed about why this was so.

These boys and girls began to consider seriously the reasons why the retail grocer has to charge more for his goods. They

listed the expenses that the grocer incurs in running his business. They recognized quickly that the grocer must also have a salary for himself and sufficient money to buy new stock and equipment. From this discussion grew a clearer understanding of the terms *wholesale* and *retail*.

Another fact was evident to the children. In running their grocery store they would have very few of the expenses incurred by the regular grocer so they realized that they would not have to sell their products for a great deal more than they paid for them. It was necessary for these seven-year-olds, however, to consider what the effect would be on the neighborhood grocer if they sold their canned goods for considerably less than he could. Two things were considered. The fact that they would be selling only a relatively small amount of goods and only for one or two times seemed to indicate to them that no great harm would be done to the neighborhood grocer. Second, they had no particular reason for wanting to make money. As they talked this problem over, they felt that they did not want to sell the goods for exactly what they paid for them. As one child said, "We want to do things like a real grocer does and that isn't the way he does it." They considered what they might do with the money they made and came to the conclusion that the Red Cross could certainly use such money to good advantage if they donated it. That they were going to make a contribution to the war effort gave the group an even greater impetus for working hard to make their store a success.

During these discussions about the money to be made from their sale, the word *profit* was used by the teacher. The children asked what she meant by that, and they were helped to see that the money they had been calling "the money we will make" could be classified as *profit*. From then on this term was used by these seven-year-olds with good understanding.

THE children with the teacher's help selected from the price list the items in which they were most interested. Their next problem was to find out what their selections would cost them. They decided that the best way to do this was to put the prices down and add them. The children listed the prices on the board for all to see. At first they were unconcerned about keeping their numbers in straight lines, but they

soon found that they could not add them if the dollars were not under the dollars, and the cents under the cents. This adding of the columns was a slow process, but every child tried his best to help in the figuring because he was vitally concerned to know what was going to be bought. They found when they had calculated the price of all the things they wished to buy that the amount was $40.75. This seemed like a very large amount of money to them, and they felt that they should eliminate some of the things. They decided to buy only canned vegetables, and they chose peas, corn, lima beans, tomatoes, spinach, and green beans. When they figured the cost of these 6 cases, they found that it came to $15.70.

They were ready now to ask the Student Council for the needed money. When the president (a high-school Senior) came in to make the arrangements with the group, he assured them that they could have the money, but that the Student Council usually took all the profit made by a group when they loaned money. The children explained what they wanted to do with their profit, and the president agreed to consult the rest of the council.When he returned to the second grade, he told them they could have the money if they paid some interest. "Interest! What is that?" they all asked. This older boy carefully explained what he meant by interest and said that the Council had thought that the second grade should pay back $16.00 for the $15.70. The children began to figure how much interest they would have to pay, and quickly saw that it was 30 cents. Of course, they did not figure the percentage of interest. They felt that this was a fair amount.

Then the president said he had a check ready for them for $15.70, but that they would have to give the Council a note. "Why does the second grade have to give a note and what is it?" they asked. The boy explained that the Council had to know where its money went, and that the second grade would promise to pay it back. This note was then composed by the group and given to the president:

March 3, 1942

We have borrowed $15.70 from the Student Council. We promise to pay it back by April 3, 1942, with an interest of 30 cents.

THE SECOND GRADE

The check which the Student Council had given them was examined carefully by each child. They watched while the

teacher endorsed the check (it had been made out in her name) and then the entire group went to the office to get the money for it. This money was counted very carefully several times to be sure that the amount was right.

THE order for the 6 cases of canned vegetables was sent to the wholesale dealer, and when it was delivered, the children counted out their money to the man who brought the goods and accepted a receipt from him. "Don't you think we ought to save this receipt so they can't say we didn't pay for our things?" observed one boy. The other children agreed that this seemed wise and so the receipt was carefully filed.

While the children were making all the plans for ordering their goods, they also were making plans for and constructing their store. They measured the available space and found it to be 2 yards in width. One child measured the space with a foot rule and stated that the space was 6 feet. Could this be right? They checked carefully and found that it took 3 foot rules to make one yardstick and 6 foot rules to make 2 yardsticks. Someone else said he thought that he could find out how many inches that would be. He said that he knew that there were 36 inches in one yardstick, so $36+36=72$. Each child checked him on this to see if he were right. This is merely one instance of the kind of careful checking and measuring that was done in all the construction work.

The children decided how long the store should be, how tall in order to take care of the tallest people who might use it, and how many shelves and counters and the size of each. Three committees were set up to take care of the construction work on the frame, shelves, and counters. Each committee made its plans, and then checked with the other committees to be sure that its plans did not interfere with or fail to be consistent with the others. Every day there were numerous needs for each child to make intelligent estimates, to measure accurately, and to use numbers in meaningful situations.

Before the canned goods could be sold the retail price had to be established. Some of the children suggested that they make a profit of 1 cent on each can. The other children wondered if that would give them enough money to meet the few expenses they had incurred for interest on the borrowed money and paper bags. They thought that it was wise for them

to see how much profit they could anticipate, so they figured how many cans of food they had. They put down on paper the number of cans in each of the six cases and then added these figures. From this sum they knew that they would have 1 penny for each can or 144 pennies. They were able to change this to $1.44 because they knew that 100 pennies made a dollar. When they took their expenses from this $1.44 they saw that they would have a profit of about 94 cents. This seemed a reasonable profit to them so each can was marked up 1 cent over its cost. The children counted the number of cans in each case to make sure that the correct number was in each, and also labeled each can with the retail price.

The second-grade boys and girls found out how many children there were in each group in the school, and then counted out and distributed the correct number of mimeographed price lists so that each child had one to take home. Advertisements were made by the children and displayed over the school. On each were given the price and size of each can of food.

All of the boys and girls wanted to be the clerks in the store. Because of the limited space it was impossible for them all to be clerks at the same time so taking turns seemed to be the best plan. The children thought that it would be desirable to have a clerk to wait on the customers and a cashier to receive the money and make change. A schedule was worked out so that each child had an opportunity to be a clerk and a cashier for a portion of the time that the sale was in progress.

Some time before the day of the sale several children called attention to a grave problem. They were not sure that they could figure the amount a customer owed if he bought several cans of food, nor were they certain they knew the value of the pieces of money or how to give change. "We'd better learn how to do these things, or we'll make some mistakes and won't have enough money to pay back what we borrowed," was their comment. Everyone in the group felt this concern and asked the teacher if she would help them learn the necessary things so that they would be able to take care of their sales without making errors. Of course, the teacher had been hoping that they would sense this need and would not wait until the day of their sale to recognize their inadequacy.

The children pretended to buy several cans of food from

the store and asked a child to write down on the blackboard the cost of each item. They recognized that here again was a place for keeping sums of money in straight columns when trying to add them. In figuring the cost of the items, they learned how to put down the figure which represented the groups of ones and to carry the figure representing the groups of ten, to put the decimal point and dollar sign in their proper places, and the like. After several such practice sessions on the blackboard, they then divided into small groups and worked on similar problems on paper. Such purposeful practice work was done until each person in the group felt confident that he could add the cost of items that a customer might buy.

Then the problem of recognizing pieces of money was taken up. Numerous pieces of each type of money were brought into the classroom, and the children worked with these until they could recognize them with accuracy. They attempted to make change for each other's pretended purchases. By the time the sale day came all of the children felt reasonably confident that they could do their job of being clerk or cashier.

The sale of the canned goods went off reasonably smoothly. There was very little need for adult supervision in making change. The children checked each other's addition on the bills, and there were relatively few mistakes.

When the sale was over the children counted their money and found that they had exactly what they had anticipated they would have. They paid their note to the president of the Student Council and requested him to give their note back to them so "we won't have to pay you twice." The profit they had made was counted several times because each child wanted to be certain of what he had helped to earn.

THE children felt that they had been quite successful with their canned-goods sale and were ready to undertake a more ambitious project. A woman in the community who was interested in the children's activities agreed to furnish baked goods to them at the same price that she charged several retail grocers. She requested that they not undersell the other grocers and gave them a list of the accepted retail prices. The children quickly recognized that they would make considerably more profit on this sale since the markup was so much greater. Miss C———, the baker, also told the children that they might

pay for their baked goods after the sale rather than on delivery. This extension of credit was very significant to these boys and girls. In all seriousness they asked the teacher if she thought that Miss C——— had permitted them to have the baked goods simply because she thought that they were good grocers.

The children felt that it was necessary to get orders for the baked things rather than to try to estimate what they would need and perhaps have considerably too much or too little. Order blanks which described the 6 kinds of bread, 4 types of rolls, and 9 kinds of cookies were sent home with each child in the school and distributed to other interested people. Orders came in rapidly, and it was decided that there should be two days for this sale so that the store would not be overcrowded. As the order sheet was received a child took it and calculated the amount of money the person owed. For example, many orders were for a dozen cookies at 20 cents a dozen, and a loaf of bread at 15 cents. This required the child to add 20 cents+ 15 cents=35 cents. All sorts of combinations of numbers occurred, and each child had many opportunities to figure the totals, for there were 169 orders received.

The children tabulated the orders on large sheets of paper so that everyone could see very quickly how many loaves of bread or pans of rolls had been ordered. This gave the children an opportunity to tabulate by groups of 5. They also figured how much money they would have to pay for each group of orders, how much they would sell the things for, and their profit; for example, 3 orders of pecan rolls—retail price, $.30; wholesale price, $.24. They added 3 thirty's and then 3 twenty-four's. When these totals were found they subtracted to find their profit. Practically every child was able to do this figuring with very little help.

On the day before the sale a slip of paper was given to each child in the school who had given the second grade an order as a reminder telling him how much money he would need to bring to school. Just previous to the sale, change of all kinds was brought into the classroom, and the children practiced making change and recognizing different pieces of money.

Each child again had an opportunity to be a clerk and a cashier. The children were even more confident during this sale, and adult supervision was required only in a few cases.

[*Continued on page 246*]

# Arithmetic with Understanding

*By* JOSEPHINE H. MACLATCHY AND EUGENIE HUMMEL

THE commonest technique used in teaching arithmetic is imitation—following a sample. As a reaction to the unsatisfactory results obtained from this prevalent technique, functional arithmetic has been devised. Functional arithmetic puts emphasis upon the practical use of number and its social implications. It presupposes sufficient number readiness on the part of a child for him to be able to isolate the number relations inherent in the situation and consider them by themselves. Number is thereby made secondary to the social situation in which it is inherent.

There are two dangers in this practice. The first is that the teacher may overlook the necessity of determining the extent of each child's readiness to see number in social situations. The second danger is that unless the teacher is careful many number facts similar to those in the situation are overlooked. Functional arithmetic should be supplemented by comprehensive drill.

In this article an experimental scheme of arithmetic instruction is described in which the emphasis is reversed. Number experiences are isolated; the scheme of organization used in number is explained at first by markers and later theoretically; the social uses of number are given a second place. The purpose is to give children a meaningful skill which they can manipulate correctly and which they will recognize when they see it used in social situations or will themselves be able to use effectively in social situations in which it is pertinent. This scheme does not exclude functional arithmetic, but might most advantageously be used in conjunction with it.

This report gives a birds'-eye view of a year's arithmetic work in a traditional school located in a prosperous suburb of Columbus. The classes available were a third and a fourth grade. Thus there were textbook assignments to finish and workbook pages to cover. The teacher was convinced that error was the commonest characteristic of numerical computations in these grades, and she was quite sure that some natively intelligent children just could not understand arithmetic. With these handicaps of prescriptions and presuppositions the experiment was undertaken.

THE first necessary step was to find out what the children in these two groups knew about the simplest number manipulations—counting and adding. To do this several tests were used. To determine proficiency in counting, the teacher asked each child to count aloud for her. She noted hesitations, repetitions, and the like in counting to 100. Then she asked simple questions which would show a child's understanding of the meaning of and his working familiarity with the number series. In testing addition she first used a group test in which the children were asked to fill in the sum of the 100 addition combinations. The time taken by each child was recorded and his errors determined. In the interview test the teacher flashed each combination before the child and kept two records—those whose sums he gave correctly in less than 2 seconds and those for which he eventually gave the correct answer.

The teacher found that although all the children could count by rote beyond 100—that is, they said the numbers in serial order—they were not sufficiently familiar with the numbers to 100 to be able to answer quickly such simple questions as, Which is more, 36 or 42? What is the first number after 29 ending in 5? From the delay in their answers it was evident to her that each of them had to repeat a portion of the number series to himself before he could answer. She found that the children in the fourth grade did not understand the meaning of the teens or the decades: They could not tell how 65 was made or what the position of the two digits indicated.

The error and time records for the written test of addition were compiled and then the teacher began the interview test. In one column on the record sheet she checked the combinations for which the child gave the correct answer in 2 seconds or less. Arbitrarily we defined the combinations which the child knew as those for which he gave the correct sum immediately—in 2 seconds or less. In another column she checked those combinations for which he eventually gave the correct sum. As soon as he answered she asked him how he reached his solution. She wrote down what he told her in detail for each such combination. If he gave an incorrect sum immediately or after deliberation, she recorded his amount without comment.

The error and computation records on the two addition tests were combined. Jerry, a fourth-grade boy, made 8 errors on the written test and 10 on the interview test. On both tests he gave either incorrect sums or computed 4+8, 8+4, 5+7,

7+5, 5+8, 8+5, 7+8, 8+7.[1] His computations included the following typical forms:

8+4..8+2 are 10; 4 is 2 more than 2; 10+2 are 12
6+7..6+6 are 12; 7 is 1 more than 6; 12+1 are 13
8+6..8+8 are 16; 8 is 2 more than 6; 2 from 16 is 14
8+5..counted the second addend—9, 10, 11, 12, 13

Jerry's record shows a good working knowledge of the first two decades of the number series and some understanding of addition. He used all the basic kinds of computation used by the fourth-grade pupils: working from the combination in which one addend and another number made 10 (8+2), using the double of one of the original addends (6+6 and 8+8), and counting. He used addition most often in his computations, but he once used subtraction.[2]

From records such as Jerry's the teacher compiled the facts shown in Table I. What do these facts show for the children in Grade IV? They all knew all the combinations in which 0 or 1 is one of the addends and all of the doubles. Other combinations with sums less than 10 known by all the fourth-grade children were: 2+6, 6+2, 2+7, 4+3, and 5+2. The only combination with a sum of 10 (9+1 and 1+9 are already included) known by all of them was 5+5. Only one combination (9+2) with a sum of more than 10 (beyond the mentioned inclusions, of course) was known by all of them.

Although the enrollment of each of these grades was small, the pupils were in no way academically selected. These were the only pupils at these grade-levels. The only method of selection was that their homes fell within the area served by this school—a portion of a superior residential suburb of Columbus. There is no reason to think that these children differ from the usual run of public-school children in these grades. It is likely that with an enrollment of 40 pupils each of the classifying groups appearing in the stub of a table similar to Table I would be larger and the combinations missed by one or two pupils would be fewer. These inferences cannot be verified at this time, however.

Table I shows that the fourth-grade record is just slightly

[1] These pairs of opposites do not fall near each other on either test blank; but when both were missed, the teacher recorded them together for her own information.

[2] Since subtraction is less often used in computations than addition and more often in error, it seems justifiable to conclude that it indicates a growth in number understanding beyond the use of addition in computations.

better than that of the third grade. Certainly, the fourth-grade record would encourage no one to think those pupils knew much about addition. Of course, one might use it as a basis for arguments against number instruction in the primary grades. We chose to use it as a challenge to see what might be done by developing the children's understanding of numbers.[3]

TABLE I

ADDITION COMBINATIONS NOT KNOWN* BY THE PUPILS OF GRADES III AND IV IN THE INTERVIEW TEST

| NUMBER OF PUPILS | SUMS LESS THAN 10 | SUMS OF 10 | SUMS MORE THAN 10 |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| | Grade III (12 pupils) | | |
| 1 ..... | 2+3, 2+4, 2+5, 3+2, 3+4, 4+2, 5+3 | 8+2 | 2+9, 7+7, 8+8, 9+9 |
| 2 ..... | 3+5, 3+6, 4+5, 7+2 | 6+4 | 6+6, 9+2 |
| 3 ..... | 5+4 | 3+7 | 3+8 |
| 4 ..... | ..... | 7+3 | 6+5, 7+4, 9+8 |
| 5 ..... | 6+3 | ..... | 4+8, 8+3, 8+9, 9+8 |
| 6 ..... | ..... | 4+6 | 4+7, 6+9, 9+6 |
| 7 ..... | ..... | ..... ..... | 3+9, 5+6, 7+5, 5+9 5+7, 7+6, 9+3, 9+4 |
| | Grade IV (9 pupils) | | |
| 1 ..... | 3+6, 4+3, 3+5, 5+2 5+3, 5+4 | ..... | 8+4 |
| 2 ..... | 2+6, 2+7, 3+4, 4+2 4+5, 3+6, 6+2, 6+3 | 2+8, 4+6 6+4, 8+2 | 2+9, 5+6, 6+5, 7+4 9+4 |
| 3 ..... | ..... ..... | 3+7 | 3+8, 4+7, 8+3, 9+2 |
| 4 ..... | ..... ..... | 7+3 | 3+9, 4+8, 4+9, 5+9 6+7, 7+5, 7+6, 8+9 9+3, 9+4, 9+6, 9+8 |
| 5 ..... | ..... ..... | ..... | 6+8, 6+9, 7+8, 7+9 9+5, 9+7 |
| 6 ..... | ..... ..... | ..... | 5+7, 5+8, 8+5, 8+6 8+7 |

* By definition the sums of these combinations were not correctly given in 2 seconds. The combinations listed in this table include computations and errors.

BEFORE the methods used are described, the results on certain standardized tests given in June will be summarized. During the year the grade requirements were scrupulously covered. Grade III was supposed to learn all the combinations of the four fundamental processes as well as the use of addition, subtraction, and multiplication with three-place

[3] It so happened that because of administrative changes within the teaching staff this teacher also taught number to the second grade for 20 minutes a day throughout this school year. Although she had to cover certain assignments and complete a workbook, she adapted the techniques described here to the seven-year-olds. The results were interesting.

numbers and short division.[4] The fourth grade was supposed to relearn the combinations and continue manipulative processes to thousands including long division with two-figure divisors.[5]

Mimeographed tests for the 100 combinations of each of the fundamental processes were completed perfectly by all the third-grade pupils and all the fourth-grade pupils in June.[6] These tests were repeated in the fall, and the records can be found in the appropriate columns of Tables II and III. One illuminating measure of the effectiveness of third-grade learning is found in the fall addition-test scores of last year's fourth grade and the scores of this year's fourth grade. The latter group's record is given in Column 2, Table II. Last year's fourth grade made the following errors on the two addition tests in September, 1941:

| | Written Test | Interview Test | | Written Test | Interview Test |
|---|---|---|---|---|---|
| Barton | 0 | 1 | Glenn | 14 | 21 |
| Helen | 1 | 6 | Bill | 16 | 26 |
| | | | Carol | 24 | 36 |
| Robert | 3 | 8 | Ross | 31 | 46 |
| Sara | 5 | 9 | | | |
| Jerry | 8 | 10 | | | |

As an impersonal check on the success of the experiment, all the children were given the fundamental-operations and problems subtests of the arithmetic test of the Analytic Scales of Attainment.[7] The tests were repeated early in September. The scores for each test and its repetition are given in the columns of Tables IV and V. The average scores for the third-grade pupils in June, 1942, have the following mental-age and grade equivalents in terms of c-score interpretations: fundamental operations, 10 years 10 months and 5–3; problems, 11 years 9 months and 6–2. The average equivalents in September were 10 years 3 months and 4–8 for fundamental operations; and 11 years 6 months and 5–10 for problems. The averages become more interesting when compared with the standard "number correct" set for the beginning of Grade IV by the test authors—9 in fundamental operations and 7 in problems.

[4] One of the first tasks of the teacher in writing her report, which she began in September, was to analyze the grades' assignments and the processes included within the textbook commitments.

[5] The workbook and textbook were used only for review purposes.

[6] No children were kept after school for arithmetic during this school year. After the first 8 weeks the teacher gave less time to arithmetic than in other years she had allowed on her schedule.

[7] These tests were compiled by L. J. Brueckner, Martha Kellogg, and M. J. Van Wagener, and are distributed by Educational Test Service of Minneapolis and Philadelphia.

The average scores of the fourth-grade pupils also exceed the authors' standards since the "numbers correct" set for the beginning of Grade V are 15 and 14, respectively. In the June testing all the fourth-grade pupils got all but two of the 25 examples correct on the fundamental-operations test. The two examples not attempted by any of the pupils were: ¾ of 18 and ¾—¼. These children had a conversational understanding of fractions, but they had received no instruction on the manipulative processes. The mental-age and grade equivalents for the fourth-grade average scores are:

| | June | September |
|---|---|---|
| Fundamental operations— | | |
| Mental age | 14 years 2 months | 12 years 0 months |
| Grade | 8–8 | 6–5 |
| Problems— | | |
| Mental age | 13 years 8 months | 13 years 0 months |
| Grade | 8–0 | 7–5 |

In both tests all of the children of both grades handed in their papers before the time allotment for the test had passed.

Tables IV and V show two facts when viewed in terms of the author's standards: first, unusual attainments and, second, unusual persistence of the processes learned. There is a loss over the summer, but neither grade comes closer to the standard for the grade it is entering than last year's third grade when it entered Grade IV in September, 1942, its average score in fundamental operations was 4–8.

Also these tables show a remarkably narrow range of attainments in June—not only are the records good but the grade range is narrow. For example, the third-grade range in fundamental operations extends only from 5–0 to 6–2, while the range and average of the fourth grade are identical—8–8.

MANY techniques were used in reaching this result. First, the children were put in groups whose members had similar addition attainments. If the reader will turn back to the open table showing the number of addition errors made by last year's fourth grade, he will find the grouping shown by the wide space within the table. Barton and Helen were Group I; Robert, Sara and Jerry belonged to the second group. Instruction was suited to what they knew and what they needed to know. At the end of 8 weeks the groups had disappeared, for Group III now had almost mastered addition, and the children were proficient enough to share the instruction in subtraction

being given to Groups I and II. The members of the third group did not let up their vigilance, however, and by June their records were as good as the best in the class.

During the first weeks all three groups shared the study of "How Numbers Are Made" and the development of column

TABLE II

THIRD-GRADE ERROR RECORDS ON COMBINATIONS IN THE FOLLOWING AUTUMN

| | Addition | Subtraction | Multiplication | Division |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| Mary | 0 | 0 | 0 | 1 |
| Nancy | 0 | 0 | 0 | 0 |
| Louise | 1 | 0 | 0 | 7 |
| Gerry | 0 | 0 | 1 | 2 |
| Peggy | 2 | 0 | 1 | 1 |
| Robert | 1 | 3 | 1 | 3 |
| Edwin | 0 | 1 | 2 | 0 |
| Sara | 0 | 0 | 3 | 2 |
| Eugene | 0 | 0 | 0 | 0 |
| Gordon | 0 | 6 | 1 | 6 |
| Marcia | 3 | 0 | 1 | 3 |
| Joyce | 5 | 1 | 3 | 0 |

TABLE III

FOURTH-GRADE ERROR RECORDS ON COMBINATIONS IN THE FOLLOWING AUTUMN

| | Addition | Subtraction | Multiplication | Division |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| Robert | 0 | 0 | 3 | 1 |
| Sara | 0 | 0 | 0 | 0 |
| Jerry | 0 | 0 | 3 | 2 |
| Carol | 0 | 1 | 5 | 4 |
| Ross | 3 | 0 | 0 | 8 |
| Barton | 1 | 1 | 0 | 0 |
| Glenn | 1 | 0 | 0 | 1 |
| Helen | 0 | 0 | 1 | 2 |
| Bill | 0 | 0 | 0 | 0 |

addition through the use of addition combinations and the facts of the number series. Group II had combinations to learn beyond 10, and Group III had all combinations except those with sums of 2, 3, and 4 to learn. It therefore happened that Group III had more frequent arithmetic classes during the first two months of school than Groups I and II. They soon saw that they were making progress, and they asked to take practice material home. Groups later appeared in each grade for a short time, but each disappeared when its use was served.

TABLE IV

FOURTH-GRADE PUPILS' RECORD OF "NUMBER CORRECT" ON THE ANALYTIC SCALES OF ATTAINMENT IN ARITHMETIC IN JUNE AND THE FOLLOWING SEPTEMBER

| | FUNDAMENTAL OPERATIONS* (25 examples) | | PROBLEMS TEST* (25 problems) | |
|---|---|---|---|---|
| | June '42 | Sept. '42 | June '42 | Sept. '42 |
| (1) | (2) | (3) | (4) | (5) |
| Mary | 19 | 19 | 21 | 24 |
| Nancy | 17 | 14 | 20 | 20 |
| Louise | 17 | 13 | 19 | ..... |
| Gerry | 17 | 13 | 19 | 19 |
| Peggy | 17 | 17 | 19 | 14 |
| Robert | 16 | 12 | 19 | 17 |
| Edwin | 16 | 16 | 19 | 16 |
| Sara | 16 | 14 | 19 | ..... |
| Eugene | 16 | 17 | 18 | 21 |
| Gordon | 15 | 16 | 18 | 17 |
| Marcia | 15 | 10 | 18 | 16 |
| Joyce | 15 | 9 | 18 | 14 |
| Average | 16.3 | 14.1 | 19. | 17.8 |

* Authors' norms for the end of Grade III: fundamental operations, 9; problems, 7.

TABLE V

THIRD-GRADE PUPILS' RECORD OF "NUMBER CORRECT" ON THE ANALYTIC SCALES OF ATTAINMENT IN ARITHMETIC IN JUNE AND THE FOLLOWING SEPTEMBER

| | FUNDAMENTAL OPERATIONS* (25 examples) | | PROBLEMS TEST* (25 problems) | |
|---|---|---|---|---|
| | June '42 | Sept. '42 | June '42 | Sept. '42 |
| (1) | (2) | (3) | (4) | (5) |
| Robert | 23 | 20 | 25 | 24 |
| Sara | 23 | 23 | 25 | 24 |
| Jerry | 23 | 19 | 25 | 22 |
| Carol | 23 | 19 | 25 | 24 |
| Ross | 23 | 21 | 25 | 21 |
| Barton | 23 | 21 | 24 | ..... |
| Glenn | 23 | 18 | 24 | 25 |
| Helen | 23 | 20 | 23 | ..... |
| Bill | 23 | 17 | 23 | ..... |
| Average | 23 | 19.7 | 24.3 | 23.3 |

* Authors' norms for the end of Grade IV: fundamental operations, 15; problems, 14.

The purpose in this experiment was to appeal to each child's understanding of number and develop it. What devices were used? The first was the use of markers. The second was social situations having number implications. The third was variety

in solving problems. The fourth was emphasis upon accuracy and its laborsaving and timesaving attributes. The fifth was developing the habit of checking one's own computations.[8] The sixth was searching for uses of number in everyday living, making scrapbooks about number, playing games, reading books,[9] and the like. The seventh concerned the teacher primarily. It involved the careful preparation of all the teaching materials. Instruction was guided by a detailed logical analysis of the steps involved in the process, and the practice exercises were rigidly organized to use only those combinations which the children had at that time mastered. As soon as a combination was introduced, it was used in the appropriate process.

THE use of markers in this experiment was not the occasional use of some teachers, but daily use in understanding new manipulative processes. For example, the fourth grade learned their long division from the use of markers. In both grades combinations were seen first in markers.[10] A child who had difficulty with a particular combination was encouraged to lay it out so that he could see it.

The teacher found a discarded sand table in the building and appropriated it for her arithmetic work. Since the top was unfinished, chalk marks on it were clearly legible and were easily erased. The children soon called the time spent around the old table with the markers their "laboratory period." The use of the table can be well illustrated by the part it played in teaching column addition. When the children were sure of the numbers in the first five decades of the number series, column addition was introduced. On the table the teacher wrote a column of numbers, and the children laid in a horizontal line from each digit its equivalent number of beans. The children found that by counting the beans they reached the same sum which the teacher obtained by adding the numbers in the column. Adding a row of numbers was just a quick way of counting. Then beside the column of numbers the children laid equivalent groups of picks. They began to add the small

[8] On the June test all fourth-grade children were sure their 23 examples were right for they had checked their reckonings twice.

[9] Early in the year the teacher read to the children of the two grades David Eugene Smith's *The Wonderful Wonders of 1-2-3*.

[10] The pupils' markers used were the boxes of 100 brightly colored cocktail picks which are found in any Five-and-Ten. This teacher had large boxes of toothpicks for large computations.

groups of picks, and as they reached ten and its later multiples they tied a string around each group of 10 picks. They soon said, "When you add you only add ones, don't you?"

This scheme of column addition was repeated many days. It was an old story to the teacher, but not to the children. Soon everyone understood changes of decades in adding—a new decade was just another bundle of 10 picks. When the marker form of column addition became clear, they reproduced it by numbers written at the side of the column being added; the fact that in addition of single numbers in a column only the ones are added reached a more theoretical level of seeing and ultimately of understanding. For example, in adding 18 and 3 the child continued to add 8+3, as when adding markers, but after putting down the 1 of the 11 he thought, "The first number after 18 ending in 1 is 21." The children were encouraged to drop this aid to adding as soon as they became proficient enough. They needed no urging for children are all in favor of laborsaving devices.

The use of markers continued through each new process. Their multiplication combinations were built up under captions similar to "2 as multiplier and 2 as multiplicand" rather than in the usual tables. They found from the picks that three 2's by the simple expedient of moving the columns of picks farther apart became two 3's. This they appreciated for to them it seemed learning two facts at once—3 times 2 and 2 times 3.

EVERY opportunity to see number in social situations was seized upon. Excursions to the Historical Museum, the Zoo, the Education Press; picnics, luncheons, and other parties, all were used. The third-graders in arranging for their first picnic had to use the picks as tallies. Committees were appointed to care for the various details such as buying the food, preparing it, and the like, but first the amounts to be purchased and the necessary money had to be worked out by the whole class. All sat around the old sand table. They decided each person would want three wiener sandwiches. So each person laid in front of himself 3 picks to represent his three wieners. These were collected by the committee and counted and checked. The committee had found the number of wieners in a pound so piles of that number were counted out until all the picks were exhausted. Next the picks became cents, and a pile of picks

equivalent to the number of cents which must be paid for one pound of wieners was laid down to correspond to each of the needed pounds of wieners. The picks next represented the buns. The committee had found that the baker sold buns at so much a dozen. The number of dozens was determined, and the needed money was computed. Then the piles of picks representing money were counted, and the sum in dollars and cents was written on the board by the teacher. Next, each one's share was determined by dealing the picks representing the cost one by one to the children sitting around the table until all were gone. This laborious method of tallying was used because these third-graders knew only two arithmetic processes—counting and adding. The teacher brought silver money and exchanged it for the pennies brought in by the children, and in this way she made the equivalence within the monetary system clearer to them.

Fourth-graders kept a record of prices of the new garments bought for them over certain periods. They computed the costs of various parties and excursions in as advanced arithmetic processes as they were at the time able to use.

VARIOUS ways of solving problems were encouraged—drawing diagrams or pictures, writing out the parts of the story, and solving by various fundamental processes or combinations of them were encouraged.[11] A child would say: "I could do this by addition or by multiplication." Sometimes the children vied with each other to see who could think of the most ways to solve a problem. When a new type of problem was found, the teacher helped the children to write out what they knew systematically so that it would aid them in solving the problem. The children became skilled in writing out what the problem said in a way that led to the solution. If there were several ways of solving a problem, any one or all of them were accepted by the teacher.

Accuracy was emphasized. A child was encouraged to check his own errors by using his picks. In this fashion he learned that an error is failure to comply with an objective standard, and one can often find one's error. Each kept a list of the combinations which he missed and each was responsible for his

[11] MacLatchy, Josephine H. "Variety in Problem Solving," *Education*, LXI (April, 1941), pp. 453–57.

own learning of them. If a child felt uncertain of a combination, he was urged to lay it out for himself and determine its correct solution rather than make a mistake. He soon decided that it took less time to learn the combinations than to work them out repeatedly.

To help the children understand that multiplication was a quick way of doing addition—multiplication problems were for some time checked by adding the multiplicand the number of times indicated by the multiplier. Later until division was mastered multiplication was checked by repeating the computation. Addition columns were checked by adding in the opposite direction—up by down, and down by up. Subtraction examples were checked in one of three ways, and eventually division was checked by multiplication. Proficiency in each process was kept alive by continued reference to it. Interrelations of processes were not overlooked, and an error in subtraction or multiplication in a division problem was also entered in an individual's list of combinations to be learned.

The children used picks and Scotch tape to make a scrapbook showing various facts about numbers. They were very proud of this book and showed it to visitors, as well as used it themselves to verify uncertainties which arose. The children asked one of the produce companies by letter for a set of cut-outs picturing various foods. Sometimes they played cafeteria and used real money for their purchases from a supply provided for that purpose by the teacher. This required the auditing of amounts by two pupils of the sums given to pupils and received back from them and from the cashier, as well as the making of change by the pupil who was cashier. They also sometimes estimated the numbers of vitamins in the food they selected.

Any aid which would make an arithmetic process more easily understood was used. For example, numbers were written at the side of added columns and the long form of division was used from the beginning. So-called "short division" was taught to fourth-grade pupils during May as a short way of doing division when a pupil is sure of his division facts.

All sorts of devices were used to develop the children's interest in arithmetic. In the number scrapbook they put stories they found in newspapers and elsewhere which used numbers to tell the story or which were understood better if one knew about arithmetic. They found the ways their parents used

[*Continued on page 246*]

# EDITORIAL COMMENT

THE present issue of the BULLETIN is devoted in large part to two articles on elementary-school arithmetic. The Government has found a great dearth of mathematical skill among the young men in the armed forces. Educators for many years have known that there was something the matter with the teaching of arithmetic in the elementary school and with other branches of mathematics in the high school. Various panaceas have been offered to correct the error of our ways. We have listened to the advisers, wise and not so wise, but the trouble has not been obviated. Several misinterpretations and oversights have increased our difficulties.

One serious misinterpretation of the place of mathematics in our lives has been the fiat that numerical instruction should be limited to minimum essentials. In a public school attended by rich and poor, clever and dull, the future leaders as well as the future followers in a democracy—who can decide what the minimum essentials are? Who is able to look ahead—education does have to look ahead regardless of many educators' theories to the contrary. John Smith, who can be in school only a few years, ought for his own future self-respect to learn as much about number as he can take. Peter Smythe, who may have anything in education which he wishes and who is brilliant, should be set well upon his way—he has a long way to go—for democracy needs technically skilled leaders as well as statesmen. Why should we limit instruction—nature's restrictions of ability offer serious enough problems without artificial limitations.

A second obstacle to arithmetic instruction in the elementary school has been the misinterpretation of aids to first steps in arithmetic. Many of these helps have been designated "crutches"—an unfortunate name surely with unpleasant connotations. But within them some teachers include, and therefore eschew, such helpful devices as allowing children who are learning to add columns of figures to write the successive sums at the side of the column as they add. If intelligently used, this device is an excellent indicator of the real meaning of addition, for it combines the addition combinations logically with the number series. The anathema of "crutches" has led many

teachers to avoid the simplicity of first steps and has been a fruitful cause of arithmetic difficulty.

Disregard of individual differences is another obstacle which blocks our way. Research has shown that individual differences in number knowledge are present from the first day in Grade I. These differences do not necessarily parallel differences in native ability. Natively gifted children in Grade I are found among those who have not noticed that specialized language—the first steps in number. They may not even know its simplest vocabulary—rote counting. Some six-year-olds, on the other hand, have done a lot of thinking about number. Their familiarity is too comprehensive to be the result of parents' haphazard instruction of three-, four-, and five-year-olds. A four-year-old on the way home from Sunday school was talking about the luncheon which had been served. To continue the conversation a bit further her aunt asked: "How many children had orange juice?" Her young niece replied: "Seven children —four and three"—evidently remembering the grouping at the tables. The aunt's attention was diverted for a few minutes; when she again turned to the niece she found her still thinking about the 7 children, for she was saying: "Five children and 2 children are 7 children, and 6 children and 1 child are 7 children." The chances are that she, when six years old, will be completely familiar with many of the addition combinations. Why should her thinking be confused and her understanding hampered by waiting while classmates who have specialized in other forms of activity take the first steps in number which she covered two or three years previously? Research has shown that these original differences tend to persist. More than four hundred children whose number knowledge was tested during their first two weeks in Grade I were given specially devised objective tests in arithmetic at the end of Grade V, and the results showed that the gap between the numerically informed and uninformed in Grade I had not been closed. The children who knew the most in Grade I still knew the most in Grade V. This in spite of the fact that those who knew the most about number were scattered throughout the percentile ratios of the Pintner-Cunningham intelligence test in Grade I and the Otis intelligence test in Grade V.

The two types of arithmetic instruction described in this BULLETIN are not mutually exclusive in the opinion of the

[*Continued on page 245*]

# READINGS

## *Books to Read*

McKim, Margaret Grace. *The Reading of Verbal Material in Ninth Grade Algebra.* New York: Teachers College, Columbia University, 1941. iv+133 pp. (Teachers College, Columbia University, Contributions to Education, No. 850)

In this report of her doctoral study Miss McKim presents a statistical treatment of the relationship between a reader's efficiency in reading algebraic and non-algebraic material, and second, the relationship between achievement in reading various types of algebraic and non-algebraic material and general achievement in algebra.

Defining reading quite broadly as "all the intellectual activities that may be called into play by the purpose which takes the reader to the printed page," the author centers her attention upon the vocabulary and symbolism which are commonly used in algebra textbooks in the definitions of terms, explanation of processes, and problem statements. Two tests were constructed, one on reading problems in algebra and one on reading explanatory passages, and these together with four other standardized intelligence and achievement tests were administered to eight groups of ninth-grade children of a New York high school. Factor analyses were made for both the experimental and control tests, and intercorrelations were carefully computed to determine the relationships between combinations of tests.

Although some question might be raised concerning the elaborate quantitative treatment of factors of comprehension which are decidedly qualitative in nature, several conclusions of interest to algebra teachers are suggested. There was found to be a significant relationship between the ability to answer correctly a verbal algebra problem and the ability to answer correctly a symbolic statement of the same problem. The proficiency in reading explanatory passages was also revealed as the best single prognosis of algebra achievement. One very obvious implication of this study is that algebra teachers should deliberately stress the reading skills particularly appropriate to this kind of material.

Dale Wantling

Groggans, Sadie. *Units of Work and Centers of Interest in the Organization of the Elementary School Curriculum.* New York: Teachers College, Columbia University, 1940. vi+140 pp. (Teachers College, Columbia University, Contributions to Education, No. 803)

This doctoral dissertation is an analysis and evaluation of two antithetical points of view in curriculum making in the elementary school, though as a matter of fact the study could be as appropriately applied to the secondary-school curriculum.

The first point of view examined by the author is to a large extent that which is embodied in the writings of such educators as Judd, Morrison, and Bagley. It holds that the curriculum should to a large extent be made up of systematic race experience, organized in terms of the maturity level of the student, and designed primarily to transmit the cultural heritage. There

is to be no nonsense about pupil planning, except as the teacher by such means may succeed in interesting the pupil in what the curriculum maker has decided in advance should be learned by the pupil. The author finds that the term *unit of work* applies for the most part to curriculums developed from this point of viow. While there are many divergent definitions of this term, in general it may be said to refer to a concentration of subject-matter radiating from one subject as a core, a combination of the materials of a subject under comprehensive headings, the organization of subject-matter around strategic positions, the synthesis of subject-matter and method in the project and in the problems, and unification of knowledge by means of principles and themes.

The second point of view concerning the curriculum is that which is held by the Dewey school of experimentalists. For this group experience is prior to thought. Subject-matter is of use only as it helps to interpret the on-going experiences of the learner. Preorganized bodies of subject-matter are not useful as sequential steps in learning, but only in helping the pupil to generalize and extend the range of his meanings. Some preplanning can be done by the teacher, but its character is in terms of anticipating stages of growth and development, in arranging a rich environment, and in anticipating the kinds of subject-matter which may be helpful to the learner. The goal of education is to refine the democratic way of life, instead merely of transmitting it. The term "center of interest" as a basis for curriculum making seems appropriate to this point of view. It is interpreted as: signs and dynamics of dawning power, contant needs around which the curriculum is built, genetic tendencies which evolve with experience, cores from which to orient the child to the social world, and sequences of the major areas of the curriculum."

The author admits that there is "a confusion of tongues" concerning the use of the two terms *units of work* and *centers of interest* but seeks in her discussion to clarify their use. The result is not too successful, and tends to be something of an oversimplification of educational ideas which cannot easily be categorized.

The discussion of sequence is probably the high spot of the dissertation. Here the treatment is informative and scholarly. There is an excellent bibliography.

HAROLD ALBERTY

BUSH, GEORGE L. *Science Education in Consumer Buying.* New York: Teachers College, Columbia University, 1941. x+228 pp.

FLOYD, OLIVER R., and KINNEY, LUCIEN B. *Using Dollars and Sense.* New York: Newson and Company, 1942. 314 pp.

HAMBLEN, STEWART B., AND ZIMMERMAN, G. FRANK. *Wise Spending.* New York: Harper and Brothers, 1941. xi+448 pp.

These three books indicate that the problem of education for intelligent consumption is getting a toe hold in the curriculum. *Science Education in Consumer Buying* is designed to help teachers and laymen to set up certain standards to judge the worth and utility of their purchases. The first third of the book appraises several previous publications on consumer buying. The material in this volume is presented as a series of generalizations used as topic

sentences. Among such generalizations are the following:"Consumer education materials are likely to consist of minor facts," "Adulteration of foods is extensively practiced," "Publicity in vitamins is often misleading," "Federal government standards are little known," "Confidence in trade names and merchants is necessary." "There is great need for more complete labels." The volume is a very valuable one for teachers.

*Wise Spending* deals with a number of important topics in the field of consumer education. The approach seems bookish and mature. Sometimes, too, the statements are distressingly obvious, such as "Shoes are one of the most important articles of clothing." The chapter on recreation says little or nothing about radio, movies, or newspapers, three of the chief ways that young people do have fun. The vocabulary is unnecessarily difficult at points.

*Using Dollars and Sense* approaches the problem of consumer education directly from the point of view of the student. It is a simple book but one which deals with significant problems in consumer education. The exercises are especially good, since they are real and not merely made up. The photographs are well selected and the comments under them are good. It should be well-received by students.

EDGAR DALE

DEARBORN, WALTER F., AND ROTHNEY, JOHN W. M. *Predicting the Child's Development*. Cambridge, Massachusetts: Sci-Art Publishers, 1941. 31+ 360 pp.

The monumental study of physical and mental growth carried on for twelve years by the Harvard Psycho-Educational Clinic has been expertly analyzed in technical monographs by Shuttleworth and others. There is need, however, for a semitechnical presentation for educators and psychologists not specifically specializing in the field. Such was, apparently, the purpose of Dearborn and Rothney—a purpose not very well achieved. The book is too heavy for most of the intended readers.

Yet it must not be lightly dismissed. Here we have the record of 1,350 cases studied over twelve years. In all, 190,000 physical and 30,000 mental measurements are reported. This is a rich mine of information.

A few of the conclusions may be given. Prediction of physical growth is hazardous, particularly in adolescence. On the other hand, the child not subject to revolutionary changes in environment tends to remain in much the same classification mentally from age eight to age sixteen—that is, to use the misleading but current terminology, the intelligence quotient remains fairly constant. (The study gives evidence—as if it were needed!—that both mental age and intelligence quotient should be abandoned for more suitable units of measurement.) Of practical value to the school is the proof that the rapid growth physically experienced around puberty is no excuse for a slump in school performance. Finally, individual variations are so numerous and so sharp that comparisons with averages become almost meaningless or indeed definitely misleading. Judgment about a person's physical status should be made in relation to his own past rather than to any kind of group average.

These findings may not seem startling. Indeed, we may say that in general few new general principles have emerged from the Study. Proof has been adduced, however, for principles which had rested on insecure bases. Most

important for the future is the wealth of detailed fact which, in the fullness of time, will be integrated into a richer picture of human development.

HORACE B. ENGLISH

SPADINO, E. J. *Writing and Laterality Characteristics of Stuttering Children.* New York: Teachers College, Columbia University, 1941. viii+82 pp. (Teachers College, Columbia University, Contributions to Education, No. 837)

This book was written with a view toward recording more data on the laterality theories of stuttering. Since he was concerned with writing and laterality characteristics, he reviewed only those research reports dealing directly with those two phases.

Tests were made of 70 elementary-school stutterers and 70 matched children who did not stutter. Testing was on the following functions: handwriting and composition, intentional mirror writing, bimanual simultaneous drawing, laterality, mirror reading, orientation, and perception. Of course, there were various subdivisions under each and the statistical approach was used throughout.

To those already initiated into the procedures used in matching and testing groups in such activities, the book presents an interesting demonstration of statistical handling and interpretation. And for those who are more interested in the speech aspect, or who are unfamiliar with such types of tests, the book contains an excellent, concise, nontechnical summary of the author's findings.

TOM STREB

## *In Paper Covers*

DEPARTMENT OF MATHEMATICS, UNIVERSITY HIGH SCHOOL, UNIVERSITY OF CHICAGO. "Mathematics Instruction in the University High School." Chicago: University of Chicago, 1940. xiii+184 pp.

To review the development and present status of the mathematics program in the University High School of the University of Chicago is to review the professional work of E. R. Breslich, and the importance of this volume is found in the fact that it presents a clear and comprehensive picture of the important contributions which this distinguished teacher has made to mathematics education in the United States. Under the leadership of Mr. Breslich the mathematics faculty of the University School studied the problems which they faced, and in this volume one finds an interesting record of their purposes, their plans, and methods of procedure. From an examination of the "course and unit objectives" which are clearly stated it is evident that this group of teachers consider their responsibility as extending beyond the narrow confines of a subject. It is interesting to see how these broad purposes are reflected in the selection and organization of instructional materials as well as in teaching procedures.

A brief outline of desirable units is given for each grade beginning with the seventh, while two of these are expanded for the purpose of illustrating in considerable detail how the teaching procedures suggested may be applied. These illustrations are comprehensive and complete, covering such important

topics as a preview and exploration of the unit, an inventory test, the study outline, provision for individual differences, the pupils' organization of the unit, and a final test followed by careful study and interpretation of the results. The manner in which the mathematics library is used for purposes of enriching the program is also interesting and suggestive and one is surprised at the extensive list of books "which, according to library records, are drawn and read by the pupils."

Mr. Breslich has long emphasized the importance of correlating mathematics courses with each other and with other school subjects, and perhaps the most significant aspect of this entire report is the continued and persistent reflection of this philosophy. Many interesting illustrations of such relationships are included, all of which will be helpful and suggestive to any teacher of mathematics. Important also is the complete bibliography of Dr. Breslich's writings, which reveal, even more than the program which he has directed for so many years, the profound influence of this distinguished educator on the teaching of mathematics in the secondary school.

H. P. FAWCETT

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## Editorial Comments

[*Continued from page 240*]

writer, who is responsible for one of the articles. They really complement each each. Both require skill in arithmetic. The teacher who is herself an unclaimed arithmetic derelict cannot use either technique successfully. She must follow the Biblical admonition, "Physician, heal thyself," or the continuity of steps in thinking—which is essential to each of them—and their significance for the children will escape her. Each method requires the ability to simplify complicated concepts to childish understanding; but such simplicity is the gift only of those who themselves perfectly understand the processes the children are using. Ingenuity, too, is necessary in each—ingenuity to keep within the system of thought and yet to guide the children's efforts in learning rather than using the commoner expedient of giving them a pattern to follow.

To the writer these two systems each can contribute its share to the problem of improving instruction in the early steps of number. One gives learning by doing in a situation fraught with social implications. The other gives the skill its intellectual interpretations and places it in the logical system to which it belongs. Children in whose instruction these two interpretations of number are blended need not be hampered by minimum essentials, "crutches," or acquired individual differences.

J. H. M.

## Functional Mathematics in Second Grade

[*Continued from page 226*]

When the money they had taken in was counted, they had $37.70. They owed $30.16 to the baker for their goods. They figured what their profit should be and then counted their money to see if it was right. They were very proud when they sent their profit as a donation to the Red Cross.

THESE second-grade children learned to use mathematics in a functional way. They were not merely learning to count, add, or subtract. They were doing something which necessitated that they know how to use these processes. They asked for help. They initiated their own drill or, as they termed it, "practice," in order to be more facile with numbers. Not only did the children in the second grade profit by the experiences during these sales, but the other boys and girls in the school who bought things also were required to use numbers in many meaningful ways, and they saw a genuine need for learning to use them quickly and accurately.



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## Arithmetic with Understanding

[*Continued from page 238*]

numbers. They also found that some of their parents used numbers all the time in the work they did. They noticed uses of arithmetic by other persons; for example, these children became interested in the so-called "additive" subtraction when one child asked why a clerk in a store added change rather than subtracted it. Later when they played games with real money, they often used this method.

Before Christmas the teacher was spending much less time on arithmetic than she had been accustomed to do in previous years. No one stayed after school to finish arithmetic. Days would pass in succession with no errors in arithmetic computations by any of the children. Many of the children said arithmetic was their favorite subject. One mother said her son could add correctly longer columns of figures than she could.